# OFFICE OF NAVAL RESEARCH
# PUBLICATIONS/PATENTS/PRESENTATIONS/HONORS REPORT
1 Oct 90 through 30 Sept 91



R&T Number: 4123033---04

Contract/Grant Number: N00014-89-J-1202

Contract/Grant Title: Large Motions of the Magnetization in Magnetically Ordered Media

Principal Investigator: Harry Suhl

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a. Number of Papers Submitted to Refereed Journal but not yet published: 0

b. Number of Papers Published in Refereed Jounals: 3 (list attached)

c. Number of Books or Chapters Submitted but not yet Published: 0

d. Number of Books or Chapters Published: 0 (list attached)

e. Number of Printed Technical Reports & Non-Refereed Papers: 0 (list attached)

f. Number of Patents Filed: 0

g. Number of Patents Granted: 0 (list attached)

h. Number of Invited Presentations at Workshops or Prof. Society Meetings: 3

i. Number of Presentations at Workshops or Prof. Society Meetings: 0

j. Honors/Awards/Prizes for Contract/Grant Employees: (list attached, this might include Scientific Soc Awards/Offices, Promotions, Faculty Awards/Offices etc)

k. Total number of Graduate Students and Post-Docs Supported at least 25% this year on this contract/grant:

Grad Students 2 and Post-Docs 0 including

Grad Student Female 0 and Post-Docs Female 0

Grad Student Minority 0 and Post-Doc Minority 0

Minorities include Blacks, Aleuts, AmIndians, Hispanics etc. NB: Asians are not considered an under-represented or minority group in science and engineering.

b. Papers Published in Refereed Journals:

Bouzidi, Djemoudi, and Harry Suhl, "Motion of a Bloch Domain Wall." Phys. Rev. Lett., **65**, 1990. (pp. 2587-2590)

Che, Xiaodong, and Harry Suhl, "Analysis of Correlation of Magnetization and Noise after AC Erasing." J. Appl. Phys., **69**, 1990. (pp. 2440-2443)

Che, Xiaodong, and Harry Suhl, "Scaling of Critical Self-Organized Megnetic Domain Formation." Phys. Rev. B, **44**, 1991. (pp. 155-158)



Statement A per telecon
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1991 Annual Report to the Office of Naval Research


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Two topics were studied during the year:

1. Interaction of domain wall motion with elementary excitations, and the resulting damping and instability mechanisms.

2. Self-organized criticality. Some further consolidation of this concept for large magnetic systems was achieved. Then, studies were begun to establish the minimum complexity a physical system must have if S.O.C. behavior is to result.

Under heading 1, we had previously used the theory of kink motion in interaction with elementary excitations to establish that the velocity of a ferromagnetic domain wall would be limited by emission and/or amplification of spin wave excitations. The limiting wall velocity is very nearly equal to the speed of the particular spin wave whose group and phase velocities are equal. When the driving field is large enough to induce this limiting velocity, the system achieves a "fixed point", a state in which a group of non-synchronous spin-waves is excited to a high, non-thermal level. When the driving field is further increased beyond a certain threshold, this fixed point goes unstable. A new fixed point is reached, at which the wall velocity has an oscillatory component added to its mean value. This work constituted the thesis subject of a student (Djemoui Bouzidi), who received his Ph.D. degree during the past year. The part dealing with velocity saturation was published in Phys. Rev. Letters in November, 1990. The more recent results on wall oscillations have been submitted to Phys. Rev. B.

Under heading 2, we are trying to determine what physical aspects of a system can lead to self-organized criticality (S.O.C.). Even though the concept appears to be very successful in at least two well-defined areas (earthquake statistics, and large, magnetically ordered systems) the reasons are unclear. The simplest algorithms used in their description <u>assume</u> that the systems get stuck in "only just" metastable states, but do not explain why. During the latter half of the past year we have been attempting to answer this question by studying the coalescence of domain walls in an applied magnetic field. Such coalescences occur in experiment by Westervelt, and they appear to terminate in states displaying S.O.C.

Up to now, we have treated only a one-dimensional version: reduction of winding number of a spiral sequence of Block-walls. So far, we find that, starting from an unstable initial state, the final stable is <u>not</u> "only just" stable, although it is far from the ground state. This could be due to the low dimensionality of this model. In any case, our next task is to determine what further complexity must be introduced to result in S.O.C.